and a power characteristic across the scanning area as a function of at least one of a distance of an object detected by the laser sensor, a direction of an object detected by the laser sensor and a type of an object detected by the laser sensor.--.

REMARKS

This Preliminary Amendment cancels, without prejudice, claims 1 to 14 in the underlying PCT Application No. PCT/EP00/01936. This Preliminary Amendment further cancels, without prejudice, claims 1 and 8 in the annex to the International Preliminary Examination Report and adds new claims 15 to 28. The new claims, inter alia, conform the claims to U.S. Patent and Trademark Office rules and does not add any new matter to the application.

In accordance with 37 C.F.R. § 1.121(b)(3), the Substitute Specification (including the Abstract, but without the claims) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to U.S. Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. §§ 1.121(b)(3)(iii) and 1.125(b)(2), a Marked Up Version of the Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. Approval and entry of the Substitute Specification (including Abstract) is respectfully requested.

The underlying PCT Application No. PCT/EP00/01936 includes an International Search Report, dated July 12, 2000, a copy of which is included. The Search Report includes a list of documents that were considered by the Examiner in the underlying PCT application.

The underlying PCT Application No. PCT/EP00/01936 also includes an International Preliminary Examination Report, dated July 5, 2001. An English translation of the International Preliminary Examination Report and annex thereto is included herewith.

It is respectfully submitted that the subject matter of the present application is new, non-obvious and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully submitted,

KENYON & KENYON

Dated: 1/23/02

By: [signature]

Richard L. Mayer
Reg. No. 22,490

One Broadway
New York, New York 10004
(212) 425-7200

09/936412
PTO/PCT Rec'd 23 JAN 2002
[11150/38]

DEVICE HAVING AT LEAST ONE LASER SENSOR AND A METHOD FOR OPERATING A LASER SENSOR

FIELD OF THE INVENTION

The present invention relates to a device for a motor vehicle, having at least one laser sensor, the laser sensor including a device for sweeping, in a scanning area, at least one laser beam that [can] **may** be emitted by the laser sensor, and including a power supply for the laser sensor. The present invention also relates to a method for operating a laser sensor of a motor vehicle, in a scanning area, using at least one laser beam.

BACKGROUND INFORMATION

In automotive engineering, information regarding the presence, the distance, and possibly the speed of objects is particularly needed for various control systems. Examples of such control systems or driver-assistance devices include automatic ranging, a pre-crash sensory system that triggers the airbags in a timely manner, lane-changing devices, or park-distance control devices. In this context, various distance sensors based on different physical principles are, in turn, [known] **conventional**, such as laser, radar, or ultrasound. Laser and/or radar sensors are almost exclusively used in the application field of automatic ranging sensors, a combination of sensors utilizing the specific advantages of the sensors being especially favorable. In the case of automatic ranging systems or lane-change assistance devices, a fixed, single-point scan of the front traffic space is not sufficient, but rather, a certain sector must at least be scanned in order to reliably detect an object. Such sector-shaped emission is inherent to the radar sensor because of the radiation characteristic of its antenna, whereas, in the case of a laser sensor, this must be done actively by moving the laser or an optical system. In so doing, the laser

beam is successively swept across the desired sector and scans it for objects. Since safety distances as long as, for example, 50 m are sometimes necessary, the laser must have an appropriately large range. For this purpose, the laser must have a correspondingly high intensity, i.e., it must be operated at a high beam power. However, this results in considerable power losses in the laser sensor, which must [first of all] be supplied by an energy source[,] and [secondly,] must be dissipated in the form of heat, using appropriate cooling measures. If passive cooling measures, such as heat sinks, do not suffice in this case, then active cooling systems requiring additional energy must be used.

On the other hand, the power output of laser sensors is limited by safety requirements for the benefit of persons in the vicinity of the vehicle, who can be struck by the laser beams and receive an eye injury due to a reflex.

[Therefore DE] **German Published Patent Application No.** 39 03 501 [proposes] **describes** an optical distance-measuring device for vehicles, which includes a semiconductor laser as an emitter for the very short infrared range[; on one hand, the]**. The** emitting capacity of the semiconductor laser [being] **is** automatically adapted to the environmental conditions, especially visibility, by a signal evaluation unit, and [on the other hand, it being] **is** adjusted to conform to eye-safety **requirements**. [In the related art, the] **The** adjustment of the power output of the system is based on the received signal. This means that the emitting power of the system is a direct function of the power of the received echo signal. If an echo signal is not received [from there], because there is no reflecting obstacle in front of the vehicle, then the default emitting power must be selected to be high, in order to cover as large an area as possible in front of the vehicle[,] and to be able to detect obstacles in this area. Therefore, an object appearing suddenly is struck

by an unnecessarily intense scanning beam. A high emitting power must also be selected in the case of poorly reflecting obstacles.

In addition, [DE] **German Published Patent Application No.** 197 07 936 [A1 proposes] **describes** a method for determining a distance of an obstacle to a vehicle, using an optical distance sensor, where the emitting power of the distance sensor is controlled as a function of the traveling speed, in order to increase eye safety.

[The] **It is an** object of the present invention [is] to provide a device having a scanning laser sensor, and a method for operating such a device, which, on the average, consume less power over time, without losing considerable amounts of information.

SUMMARY

[The solution of the engineering problem follows from the features of Claims 1 and 8.]

The present invention provides for the power output of the laser beam emitted by the laser sensor being variable as a function of the direction of the laser beam.

By varying the power input as a function of the position of the device for sweeping the laser beam, in which case the laser is supplied more power in areas of high relevance than in the less relevant areas, the average power input of the sensor is reduced, so that [on one hand,] both the power supply itself and a potentially necessary cooling system [can] **may** be dimensioned to be smaller, and at the same time, the eye safety is increased. The increased service life of the laser sensor [can] **may** be regarded as a further advantage of the present invention.

[Additional advantageous refinements follow from the dependent claims.]

An [advantageous] example **embodiment of the present invention** provides for the characteristic curve of the laser sensor's beam power being continuously varied.

Another [specific] **example** embodiment **of the present invention** provides for the maximum power of the laser sensor and/or the power characteristic across the scanning area being selected as a function of the vehicle speed[, as well].

This [has] **arrangement provides** the advantage of the beam power of the laser sensor [always] being adapted to the actual requirements of the driving situation, and the danger to people being further reduced.

Furthermore, it [can] **may** be provided that the maximum beam power of the laser sensor and/or the power characteristic across the scanning area be selected as a function of a detected object, thereby allowing both the distance of the object and, whether the object is a living thing or an article, to play a role. In particular, the location of the object with respect to the vehicle or the laser sensor is important for the characteristic of the beam power.

BRIEF DESCRIPTION OF THE DRAWING

Figure 1 is a top plan view of a scanning area of a laser-scan distance-sensing system according to the present invention.

DETAILED DESCRIPTION

The present invention is explained below in detail, using [a preferred exemplary] **an example** embodiment. [The one figure shows] **Figure 1 illustrates** a scanning area of a laser-scan distance-sensing system.

[Represented] **__Illustrated__** in Figure 1 is a motor vehicle 1 having a scanning laser sensor 3 positioned in the front area of motor vehicle 1, the scanning laser sensor being, for example, a component of an automatic ranging system and a lane-change assistance device. Laser sensor 3 includes a transmitter unit [not shown], which emits laser radiation, and a receiving device [also not shown], which receives laser radiation reflected by objects or obstacles, and [can] **__may__** evaluate it according to propagation time and angle of incidence. In addition, laser sensor 3 includes a device [for] **__configured to__** horizontally [sweeping] **__sweep__** the laser beam across a scanning range 2, which is 180° in the [represented] **__illustrated__** example **__embodiment of the present invention__**. However, scanning ranges of up to 360° are also [conceivable] **__possible__**. The device [for sweeping] **__configured to sweep__** the laser beam [can] **__may__** either swing the laser as a whole[,] or [is] **__may be__** in the form of a suitable optical system. The laser sensor is assigned a power supply, which allows the laser sensor a variable power input that it converts into laser radiation. The larger the beam power made available by the energy supply, the higher the intensity and, thus, the larger the range of laser sensor 3.

In an automatic ranging system, for example, the other motor vehicles directly in front of motor vehicle 1, which must also be reliably detected from a longer distance, are of interest, whereas motor vehicles in adjacent lanes are not as interesting. For example, they are only of interest in the immediate vicinity of motor vehicle 1, in case the motor-vehicle driver plans to change lanes, and it must be checked if motor vehicles are in the desired lane, and if one [can] **__may__** change lanes without risk. On the basis of these preconsiderations, the range of laser sensor 3 [can] **__may__** be chosen to be smaller in the segments[, where] **__that__** the scanning area sweeps over adjacent lanes. This **__arrangement__** is

[represented] **illustrated** in a discrete form in Fig. 1, three different segments I, II, and III having been selected. In this context, Segment I, for example, spans an scanning angle of -30° to 30°, and is used for detecting motor vehicles traveling directly in front. In this area, laser sensor 3 is operated at the highest power, and therefore, at the longest range. Segment II covers motor vehicles, which are in adjacent lanes, and [could] **may** possibly move into the lane of the vehicle in question, i.e. [should]**, may** be taken into consideration during a lane change, this segment II spanning, for example, a scanning angle of -60° to -30° and 30° to 60°. Motor vehicles that are nearly adjacent are detected in segment III, so that a range of 4 to 5 m [is] **may be** completely sufficient. Therefore, the average required power [can] **may** be reduced without loss of information. In addition, the optical power sweeping over a possible, adjacent sidewalk is reduced, so that the risk of damaging the eyesight of passers-by is reduced.

Apart from a stepped reduction in the intensity, the intensity [can] **may** also be reduced continuously from the mid-position, i.e.**,** the intensity function $i(\alpha)$ is a continuous function. In specific **example** embodiments **of the present invention**, where two laser-scan sensors 3 are situated on the right and left, in the front area of motor vehicle 1, angular distribution $i(\alpha)$ is selected in a correspondingly different manner, so that the most relevant areas [can again] **may** be scanned at the highest intensity.

Since the safety distance to be kept is dependent on the speed, the laser is operated, in particular in segment I, at an intensity that increases with the speed. Another option for further variation of the intensity is to pass through the different segments at different scanning speeds. Thus, segment III, for example, [can] **may** be traversed at a higher

scanning speed, in order to further reduce the risk of injuring passers-by.

ABSTRACT

A device for a motor vehicle includes at least one laser sensor. The laser sensor includes a device configured to sweep a scanning area with at least one laser beam emitted by the laser sensor and a power supply device for the laser sensor. In a method for operating a laser sensor in a scanning area with at least one laser beam, the power of the laser beam emitted by the laser sensor is varied in accordance with its direction of radiation.